DOCUMENT RESUME

ED 204 662 CG 015 280

AUTHOR Puglisi, J. Thomas; Allegretti, Christine L.
TITLE Older Persons' Perception of Letters in Words and Nonwords: Application of a Developmental Model.
PUB DATE Mar 81
NOTE 21p.; Paper presented at the Annual Meeting of the Southeastern Psychological Association (27th, Atlanta, GA, March 25-28, 1981). Best copy available.

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Age Differences; Cognitive Development; Cognitive Processes; Cognitive Style; Developmental Stages; *Older Adults; Perception Tests; *Perceptual Development; Recognition (Psychology); *Visual Perception; Visual Stimuli
IDENTIFIERS *Nonwords; *Word Superiority Effect

ABSTRACT

Although numerous studies have indicated that older persons process visual information more slowly than younger persons, the precise nature of age-associated changes in the processing of visually presented information remains unclear. Older adults (N=18) and college students (N=18) performed a visual search task in which lists of words and nonwords (presented in small-case, large-case, and mixed-case formats) were searched for the letters "a" and "r." Results supported the Allegretti-Puglisi developmental model of letter and word perception. Search times of all subjects indicated the presence of two, non-interacting phenomena: a word superiority effect (shorter search times for words than for nonwords) in both same-case and mixed-case formats; and a case effect (shorter search times for same-case than for mixed-case items) in both words and nonword conditions. Although older persons evidenced slower processing than college students in all stimulus conditions, the processing of older persons was differentially slowed in conditions which prevented automatic as opposed to effortful processing. (Author/NRB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED204662

BEST COPY AVAILABLE

Older Persons' Perception of Letters in Words and Nonwords: Application of a Developmental Model

J. Thomas Puglisi, Ph.D.

and

Christine L. Allegretti, Ph.D.

University of North Carolina at Charlotte

Department of Psychology

UNCC Station

Charlotte, NC 28223

Running Head: Letter and Word Perception

Paper presented at the 27th annual meeting of the Southeastern Psychological Association, March, 1981.

CG 015280

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

J. Thomas Puglisi

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

Letter and Word Perception in Older Adults: Application of a Developmental Model

Although numerous studies have indicated that older persons process visual information more slowly than do younger persons (see reviews by Botwinick, 1978; Fozard, Wolf, Bell, McFarland, & Podolsky, 1977; Hoyer & Plude, 1980), the precise nature of age-associated changes in the processing of visually presented information remains unclear. However, in an extensive review of the literature concerning perceptual and attentional processes in the aged, Hoyer & Plude (1980) suggest that research in the areas of automatic (vs. effortful) processing and parallel (vs. serial) processing may be particularly fruitful for an understanding of older persons' processing of visual information. They also maintain that a developmental perspective is needed when formulating and testing general theories of visual information processing. Consistent with these observations, Allegretti and Puglisi (1980) have recently presented a developmental model of letter and word perception which emphasizes automatic/effortful and parallel/serial processing. The present study constitutes an application of this model to the processing of older adults.

A Developmental Model of Letter and Word Perception

It is a well documented finding (e.g., Johnston & McClelland, 1973; Reicher, 1969; Wheeler, 1970) that a letter within a word can be recognized more easily than a letter within an equally long nonword. In an attempt to clarify the processes underlying this "word superiority" effect, Allegretti and Puglisi (1980) presented college students with a visual search task in which lists of words and of nonwords were searched for the letters "a" and

"r". These lists were presented both in same-case (e.g., word, WORD) and in mixed-case (e.g., wOrD) formats in order to confirm McClelland's (1976) hypothesis that the word superiority effect involves preliminary, parallel processing of letters and does not rely solely on perceptual unitization; i.e., on a word's form-specific, visual configuration. (According to the latter hypothesis, mixed-case formats should disrupt perceptual unitization and thus destroy the word superiority effect; Stanovich, Purcell, & West, 1979.) Results of the Allegretti and Puglisi study indicated the presence of two, non-interacting phenomena: (a) a word superiority effect (shorter search times for words than for nonwords) in both same-case and mixed-case conditions, and (b) a case effect (shorter search times for same-case than for mixed-case items) in both word and nonword conditions.

Figure 1 depicts a developmental model of letter and word perception formulated to account for these two phenomena. For the beginning reader (Figure 1a), each step between the activation of visual feature codes and the activation of word codes (a) requires attention and (b) must be carried out separately and serially (i.e., in sequence) for each letter in a word. However, as experience with letters and words is gained, the activation of steps becomes automatic (as suggested by LaBerge & Samuels, 1974). Eventually, feature codes can automatically activate abstract letter codes (similar to McFarland, Frey, & Landreth, 1978; Posner, 1969; Reitsma, 1978). Moreover, automatic processing allows serial processing of individual letters to be replaced by parallel processing of several letters, so that groups of visual features can simultaneously activate several abstract letter codes (Figure 1b). Finally, as the reader gains even more experience, the automatic,

parallel processing of abstract letter codes can activate word codes (Figure 1c). Highly efficient readers may even extend parallel processing beyond the word code level (e.g., Drewnowski & Healy, 1977; Gibson & Levin, 1975).

Figure 2 illustrates the application of this model to the word superiority effect and to the (same vs. mixed) case effect. The model explains the case effect in terms of the processing which preceeds the activation of abstract letter codes. In same-case conditions, parallel processing of visual features automatically activates abstract letter codes (Figure 2a, 2b). This activation may be made possible by a perceptual learning process based on the probability of various visual features occurring together. Since readers encounter same-case letter strings quite frequently, feature probabilities specific to same-case strings become well-learned and can be utilized in the parallel activation of abstract letter codes. However, mixed-case letter strings are encountered less often and would require a different, more complicated (and probably less well-learned) set of feature probabilities. As a result, the activation of abstract letter codes takes longer in mixed-case conditions (Figure 2c, 2d).

This activation may be the result of an automatic, parallel processing of visual features (cf., Adams, 1979; Coltheart & Freeman, 1974; McClelland, 1976: subjects presented with mixed-case letters often report "seeing" same case letters), or it may be that some minimal direction of attention is necessary to initiate the processing sequence (e.g., simply recognizing that the stimulus is mixed-case rather than same-case). In either event,

an advantage for same-case over mixed-case letter strings would result because it should take less time and/or attention to process a string of visual features which frequently occur together than to process a string of features which do not typically occur together.

The model explains the word superiority effect in terms of the processing which follows the activation of abstract letter codes. According to the model, the word superiority effect occurs because experienced readers can activate word codes automatically through the parallel processing of abstract letter codes (Figure 2a, 2c). This automatic activation of word codes facilitates the search for an individual letter because (a) the letters making up the word can be searched as a single unit, and (b) accessing a word code makes available a wealth of overlearned information associated with the code, including the word's letters and its phonological code. However, no such facilitation occurs for the nonword (Figure 2b, 2d). When automatic, parallel processing of abstract letter codes fails to activate a word code, attention must be directed to individual letter codes which are examined serially. This serial processing results in increased letter search times; hence, the word superiority effect.

Implications of the Model for the Processing of Older Adults

The Allegretti-Puglisi model explains both the (same vs. mixed) case effect and the word superiority effect in terms of automatic (vs. effortful) and parallel (vs. serial) processing. Furthermore, the model hypothesizes that the case effect and the word superiority effect are the result of automatic, parallel processing which occurs at separate, independent stages

in the processing sequence. Since the concepts of parallel processing and automatic processing are not entirely new in the aging literature, the model generates several hypotheses regarding older persons' (visual) perception of letters in words and nonwords.

First, it appears that parallel processing of visually presented information does continue throughout adulthood (Hoyer & Plude, 1980). It is feasible, then, to hypothesize that older adults would continue to display both the case effect and the word superiority effect. These effects should be demonstrated in spite of the overall slowing of visual processing associated with aging.

Second, recent evidence suggests that the distinction between automatic and effortful processing may be useful for understanding age changes in visual processing. Hasher and Zacks (1979) have hypothesized that certain kinds of processing can take place automatically, i.e., with little or no cognitive effort and utilizing little or no attentional capacity. Other types of processing are viewed as effortful because they require cognitive effort and utilize attentional capacity. Hasher and Zacks suggest that automatic processing should remain relatively intact into old age and should demonstrate little age-related decline compared to effortful processing (which requires attentional capacity). This suggestion is compatible with a number of studies in the literature (e.g., divided attention studies such as Kirchner, 1958; selective attention studies such as Farkas & Hoyer, 1980; Rabbitt, 1965) which suggest that older persons may suffer from limited attentional capacity or "processing resource" (Craik & Simon, 1980). If it is, indeed, the

case that a decrease in attentional capacity accompanies aging, then tasks which require effortful, attentional processing should "yield greater magnitudes of age-associated decline than tasks that can be performed automatically" (Hoyer & Plude, 1980, p. 234).

Automatic processing occurs at two distinct stages within the Allegretti-Puglisi model and is hypothesized to play a role in two independent phenomena, the word superiority effect and the (same vs. mixed) case effect. If older persons do experience deficits in effortful, attentional processing, then stimulus conditions which prevent automatic processing (and thereby force the utilization of effortful, attentional processes) should produce greater performance decrements in older persons than in younger persons; i.e., the performance of older persons should be differentially affected by such stimulus conditions.

These considerations generate several specific hypotheses:

1. The processing of older adults should be slower than the processing of younger adults in all stimulus conditions (i.e., a main effect of age is predicted).

2. Since it is probable that automatic, parallel processing of visually presented information continues into old age, both younger and older adults should display both the (same vs. mixed) case effect and the word superiority effect. In other words, for both younger and older adults, same-case letter strings should be processed faster than mixed-case strings, and words should be processed faster than nonwords (i.e., main effects of case and word/nonword conditions are predicted. There should be no interaction between case and

word/nonword conditions because their effects should occur at different stages in the processing sequence.)

3. Nonword letter strings (as opposed to words) should force the utilization of effortful, attentional processes when automatic parallel processing of abstract letter codes fails to activate word codes. Since older persons are hypothesized to suffer limits on effortful, attentional processing, the performance of older persons should be differentially slowed in nonword conditions (i.e., an age by condition interaction is predicted).

4. Since mixed-case letter strings may encourage (or require) the activation of attentional resources, the performance of older persons may also be differentially slowed in mixed-case conditions (i.e., an age by case interaction is predicted).

Method

Subjects

Eighteen older adults (13 female, 5 male) between the ages of 60 and 85 ($\overline{X}$ = 71 years) and 18 college students (14 female, 4 male; $\overline{X}$ = 19 years) performed a visual search task in which lists of words and nonwords were searched for the letters "a" and "r". Ten of the older persons were community-dwelling volunteers and eight were recruited from a local retirement community. All resided in middle to upper-middle class environments. College students were undergraduate volunteers from the University of North Carolina at Charlotte who received extra course credit for participating.

Materials

The stimulus set consisted of 50 words and 50 nonwords originally used by

Stanovich, et al. (1979). Words were high frequency, 4-letter words selected from the Kucera and Francis (1967) word count. Nonwords were formed by changing the order of letters in each of the words. Each word/nonword contained either an "a" or an "r". Position of the critical letter ("a" or "r") within each item was equalized across the word/nonword sets.

Words and nonwords were presented in separate, 50-item lists in three different case formats, resulting in a total of six lists: lower-case words, lower-case nonwords; upper-case words, upper-case nonwords; mixed-case words (e.g., WoRd), mixed-case nonwords (e.g., RdWo). In mixed-case lists, letter cases were alternated within each item, so that half of the items (ordered randomly) began with each case, and each case contained an equal number of "a's" and "r's". Each list was typed on a separate sheet of white paper (21 cm by 28 cm) in IBM Prestige Elite 72, 12 pitch type.

Procedure

Subjects were instructed to read through each list of items and to indicate verbally whether each item contained the letter "a" or the letter "r". They were also asked to proceed through each list as quickly as possible without making any errors. A 60-item practice list exemplifying the six stimulus types (10 items each, ordered randomly) was presented first, followed by the six word/nonword lists. Subjects were tested individually, and list order was counterbalanced across subjects.

Visual search times from the beginning to the end of each list were recorded to the nearest .01 sec. After a ready signal, the subject began responding, and the experimenter activated a timer. As soon as the response to the last list item was completed, the subject pushed a button terminating the timer.

Results

Data were analyzed using a 2 x 2 x 3 Mixed Analysis of Variance (college students vs. older persons; word vs. nonword conditions; small vs. large vs. mixed-case formats). Significant main effects indicated (a) that the processing of older persons was slower than that of college students (Table 1), $F(1,34)=23.02$, $p<.001$, $eta^2=.36$; (b) that words were processed faster than nonwords (Table 1), $F(1,34)=17.95$, $p<.001$, $eta^2=.005$; and (c) that same-case strings (not significantly different from each other; Duncan's Multiple Range, $p>.05$) were processed faster than mixed- case strings (Table 2; Duncan's Multiple Range, $p<.05$), $F(2,68)=12.86$, $p<.001$, $eta^2=.013$. A significant age by condition interaction was also obtained, $F(1,34)=4.21$, $p<.05$, $eta^2=.001$. Although both older persons and college students processed words faster than nonwords, the nonword condition resulted in differentially greater slowing among older persons than among college students (Table 1). The age by case interaction approached significance, $F(2,68)=2.58$, $p<.08$, $eta^2=.003$. Although both older persons and college students processed same-case strings faster than mixed-case strings, mixed-case strings may have resulted in differentially greater slowing among older persons (Table 2). Neither the condition by case interaction nor the age by condition by case interaction were significant ($p>.10$).

Discussion

Results were clearly supportive of the model developed by Allegretti and Puglisi to describe the processes involved in letter and word perception. As in their previous study, data indicated the presence of two, non-interacting

phenomena: (a) a word superiority effect (shorter search times for words than for nonwords) in both same-case and mixed-case conditions, and (b) a case effect (shorter search times for same-case than for mixed-case items) in both word and nonword conditions. Moreover, the data consistently supported the hypotheses suggested by the model relative to the processing of older persons.

As expected (Hypothesis 1), older adults displayed slower processing than college students in all conditions. This finding is consistent with a large body of literature indicating an age-associated slowing in the processing of visual information. More interesting was the finding that, in spite of their consistently slower processing compared to college students, older persons did display both the word superiority effect and the (same vs. mixed) case effect (Hypothesis 2). This finding lends support to existing data which indicate that both parallel and automatic processing continue into later adulthood. The findings also lend support to the contention that automatic processing should demonstrate less age-related decline than effortful processing (which utilizes attentional capacity). This contention, compatible with studies suggesting that older persons suffer from limited attentional capacity, predicts that tasks which require effortful, attentional processing should show differentially greater age-associated decline than tasks performed through automatic processing. The Allegretti-Puglisi model provides two independent tests of this prediction.

First, the model suggests that nonword letter strings should force the utilization of effortful, attentional processes when automatic parallel processing of abstract letter codes fails to activate word codes. As predicted

(Hypothesis 3), the performance of older adults was differentially slower in nonword conditions than in word conditions, compared to younger adults. Second, the model suggests that mixed-case letter strings may also encourage the activation of attentional resources. Again, the performance of older adults appeared to be differentially slowed (Hypothesis 4).

Thus, the findings of this study were supportive of the Allegretti-Puglisi model both in its general predictions regarding the processing of letters and words and in its specific predictions regarding the processing of older persons. While these results are encouraging, it must be noted that the model has, so far, been tested only relative to a single research paradigm, specifically, visual search of lists. Further research, utilizing a variety of paradigms (e.g., recognition) is needed to determine whether or not the model actually does provide a viable description of the visual processing of letters and words. Additional research should also be undertaken in an attempt to extend the model to multi-word situations such as phrases or short sentences.

Reference Note

Allegretti, C. L., & Puglisi, J. T. Word superiority: Perception of Letters in Words and Nonwords. Paper presented at the annual meeting of the American Psychological Association, Montreal, Canada, September, 1980. Extended version currently under review, American Journal of Psychology.

References

Adams, M. J. Models of word recognition. Cognitive Psychology, 1979, 11, 133-176.

Botwinick, J. Aging and behavior. New York: Springer, 1978.

Coltheart, M., & Freeman, R. Case alternation impairs word identification. Bulletin of the Psychonomic Society, 1974, 3, 102-104.

Craik, F. I. M., & Simon, E. The roles of attention and depth of processing in understanding age differences in memory. In L. W. Poon, J. L. Fozard, L. S. Cermak, and L. W. Thompson (Eds.), New directions in memory and aging: Proceedings of the George A. Talland Memorial Conference. New Jersey: Lawrence Erlbaum, 1980.

Drewnowski, A., & Healy, A. F. Detection errors on the and and: Evidence for reading units larger than the word. Memory and Cognition, 1977, 5, 636-647.

Farkas, M. S., & Hoyer, W. J. Processing consequences of perceptual grouping in selective attention. Journal of Gerontology, 1980, 35, 207-216.

Fozard, J. L., Wolf, E., Bell, B., McFarland, R. A., & Podolsky, S. Visual perception and communication. In J. E. Birren & K. W. Schaie (Eds.), Handbook of the psychology of aging, New York: Van Nostrand Reinhold, 1977.

Gibson, E. J., & Levin, H. The psychology of reading. Cambridge, Massachusetts: The MIT Press, 1975.

Hasher, L., & Zacks, R. T. Automatic and effortful processes in memory. Journal of Experimental Psychology: General, 1979, 108, 356-388.

Hoyer, W. J., & Plude, D. J. Attentional and perceptual processes in the study of cognitive aging. In L. W. Poon (Ed.), Aging in the 1980's: Psychological issues. Washington, DC: American Psychological Association, 1980.

Johnston, J. C., & McClelland, J. L. Visual factors in word perception. Perception and Psychophysics, 1973, 14, 365-370.

Kirchner, W. K. Age differences in short-term retention of rapidly changing information. Journal of Experimental Psychology, 1958, 55, 352-358.

LaBerge, D., & Samuels, S. J. Toward a theory of automatic information processing in reading. Cognitive Psychology, 1974, 6, 293-323.

McClelland, J. L. Preliminary letter identification in perception of words and nonwords. Journal of Experimental Psychology: Human Perception and Performance, 1976, 2, 80-91.

McFarland, C. E., Frey, T. J., & Landreth, J. M. The acquisition of abstract letter codes. Journal of Experimental Child Psychology, 1978, 25, 437-446.

Posner, M. I. Abstraction and the process of recognition. In G. H. Bower & J. T. Spence (Eds.), The psychology of learning and motivation (Vol. 3). New York: Academic Press, 1969.

Rabbitt, P. M. A. An age-decrement in the ability to ignore irrevelant information. Journal of Gerontology, 1965, 20, 233-238.

Reicher, G. M. Perceptual recognition as a function of meaningfulness of stimulus material. Journal of Experimental Psychology, 1969, 81, 275-280.

Reitsma, P. Changes in letter processing in beginning readers. Journal of Experimental Child Psychology, 1978, 25, 315-325.

Stanovich, K. E., Purcell, D. G., & West, R. F. The development of word re-

cognition mechanisms: Inference and unitization. Bulletin of the Psychonomic Society, 1979, 13, 71-74.

Wheeler, D. D. Processes in word recognition. Cognitive Psychology, 1970, 1, 59-85.

Table 1

Mean Search Times (Sec.) for Word and Nonword Items

	Condition		
Group	Words	Non-Words	Total
College Students	32.30	33.45	32.87
Older Persons	49.39	52.70	51.04
Total	40.84	43.07	

Table 2

Mean Search Times (Sec.) for Items in Each of Three Case Formats

	Case		
Group	Small	Large	Mixed
College Students	32.09	32.28	34.25
Older Persons	48.59	50.02	54.51
Total	40.04	41.15	44.38

Figure Captions

Figure 1. Developmental model of word code activation: (a) for beginning readers, serial processing of each letter and attention at each step; (b) for more experienced readers, automatic parallel processing of feature codes and simultaneous activation of several abstract letter codes; (c) for very experienced readers, automatic parallel processing of abstract letter codes and activation of word codes.

Figure 2. The application of the developmental model to the word superiority effect and the case effect: (a) same case words, (b) same case nonwords, (c) mixed-case words, (d) mixed-case nonwords.

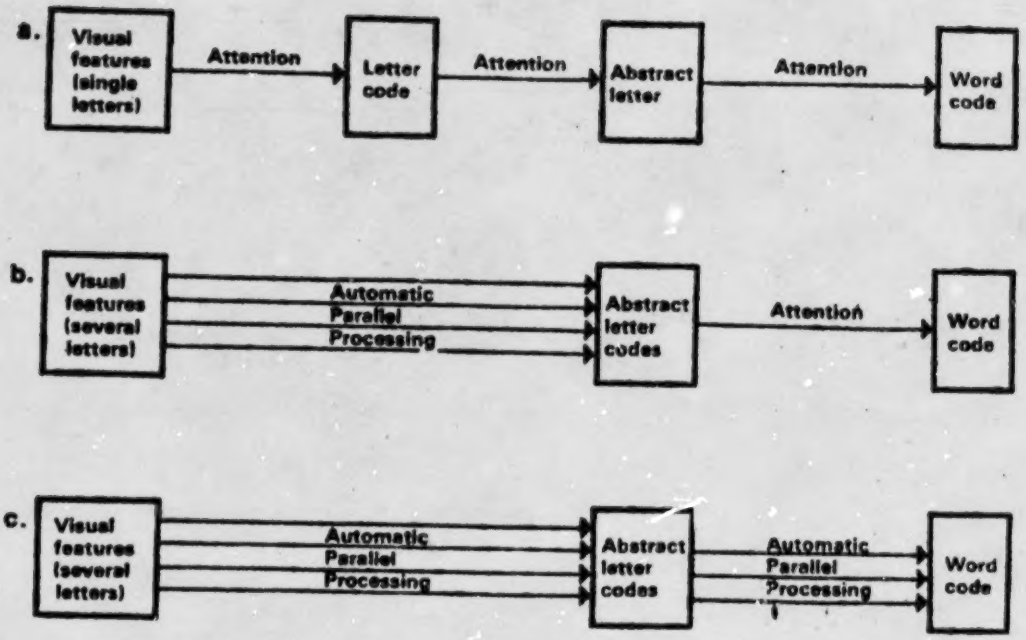

Figure 1

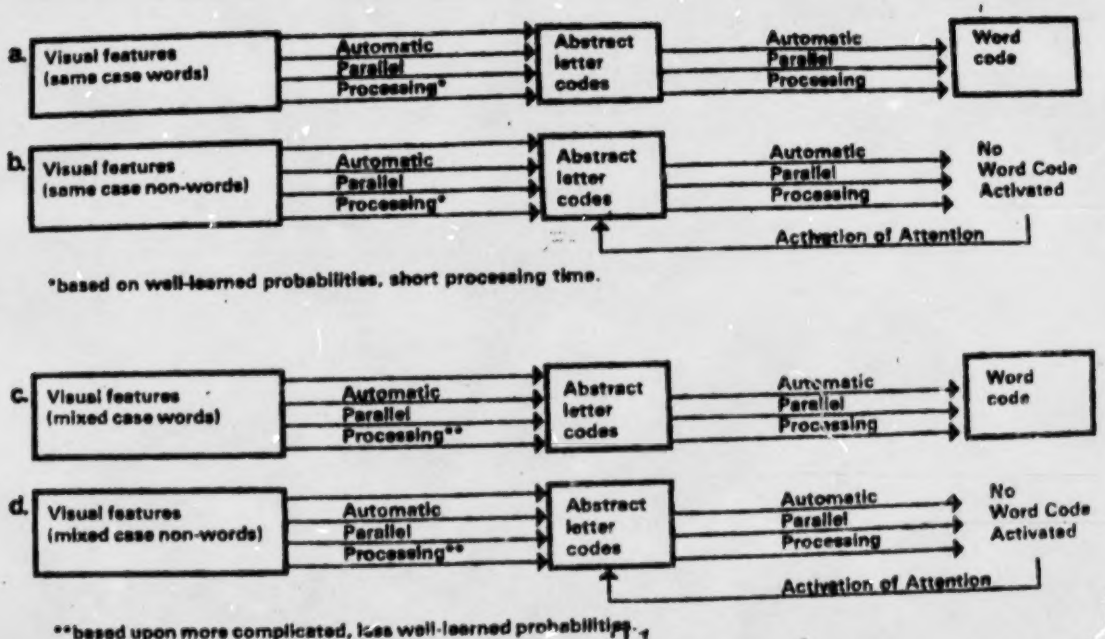

Figure 2